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EXAMINER	
BROWN JR, NATHAN H	

ART UNIT	PAPER NUMBER
2129	

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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

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Office Action Summary	Application No. 10/578,659	Applicant(s) SMITH ET AL.	
	Examiner NATHAN H. BROWN JR	Art Unit 2129	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE _3_ MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on _16 September 2009_.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) _1-51_ is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) _1-12,14-22,25-28,30-36,47,48,50 and 51_ is/are rejected.

7)☒ Claim(s) _13,24,29,38-46 and 49_ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on _06 May 2006_ is/are: a)☐ accepted or b)☒ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO/SB/08)
Paper No(s)/Mail Date _See Continuation Sheet_.
4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

Continuation of Attachment(s) 3). Information Disclosure Statement(s) (PTO/SB/08), Paper No(s)/Mail Date :7/2/07, 2/22/08, 3/20/08, 3/31/09, 9/16/09.

Examiner's Detailed Office Action

1. This Office is responsive to application 10/578659, filed September 16, 2009.

2. Claims 1-51 have been examined.

3. Examiner withdraws the restriction of claims 1-51 under 37 CFR 1.499.

4. Examiner suggests that applicant be prepared to make a restriction choice for claims 18, 19, 25, 32, and 34 should applicant decide to amend the claims such that claims 18, 19, 25, 32, and 34 become independent claims.

Objections to the Drawings

5. The drawings are objected to under 37 CFR 1.83(a). The drawings must show every feature of the invention specified in the claims. Therefore, the algorithms of claims 1-34, 35, 36, 48, and 50 must be shown in a titled: flow chart, Nassi-

Shneiderman diagram, action diagram, or Warnier-Orr diagram or the feature(s) canceled from the claim(s). No new matter should be entered.

Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. The figure or figure number of an amended drawing should not be labeled as “amended.” If a drawing figure is to be canceled, the appropriate figure must be removed from the replacement sheet, and where necessary, the remaining figures must be renumbered and appropriate changes made to the brief description of the several views of the drawings for consistency. Additional replacement sheets may be necessary to show the renumbering of the remaining figures. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either “Replacement Sheet” or “New Sheet” pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

Objections to the Claims

6. Claims 1, 35, 48, and 49 are objected to because of the following informalities: “factorising” should be --factorizing--. Appropriate correction is required.

7. Claims 1, 35, 48, and 49 are objected to because of the following informalities: “factorisation” should be --factorization--. Appropriate correction is required.

8. Claims 23, 27, 29, and 32 are objected to because of the following informalities: “analysing” should be --analyzing--. Appropriate correction is required.

Claim Rejections - 35 USC § 112, 2^{nd}

9. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

10. The terms "substantially independent" in claim 2 and "substantially independently" in claim 37 are relative terms

which renders the claims indefinite. The term “substantially independent” is not defined by the claims, the specification does not provide a standard for ascertaining the requisite degree, and one of ordinary skill in the art would not be reasonably apprised of the scope of the invention. The single use of the term "substantially independent" in the specification suggests that in “general the (vector) value of a row/column is independent of its previous value although it is possible that the previous value of a row/column may be incorporated into a weighting factor (as described further later) determining a degree of convergence of successive iterations of the method”. Here, the term "substantially independent" seems to depend on the *possibility* “that the previous value of a row/column *may* be incorporated into a weighting factor” [emphasis Examiner’s] and “a degree of convergence”.

Later, it is disclosed in the specification that:

> As previously mentioned, embodiments of the method converge extremely fast on the desired target but nonetheless generally two or more iterations of the method will be applied. Either a fixed number of iterations may be employed (providing a bound to the processing time which may be useful for some applications such as video) or the method may be iterated until there is substantially no change in the first and second matrices or until these change by less than a threshold amount, or until an error or cost function is less than a threshold value. As described in more detail later in embodiments of the method speed of convergence is controlled by a weighting factor, which may be adjusted as convergence proceeds and/or

dependent upon one or more values in the target matrix... So now, the term "substantially independent" seems to depend on the possible meanings of “extremely fast”, a “fixed number of iterations...providing a bound to the processing time”, “substantially no change in the first and second matrices”, “change by less than a threshold amount”, and “an error or cost function...less than a threshold value”. None of these seem to be defined in the specification such that one of ordinary skill in the art would be reasonably apprised of the scope of the invention (i.e., quantitatively). Therefore, claims 2 and 37 are considered to be non-statutory under 35 U.S.C. 112, second paragraph.

Claim Rejections - 35 USC § 101

11. 35 U.S.C. 101 reads as follows:

> Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.

12. Claims 1-12 and 14-16 are rejected under 35 U.S.C. 101 because the claimed invention preempts all practical applications of the recited judicial exception (algorithm).

Clearly, "digitally processing data in a data array by defining a target matrix (X) using non-negative matrix factorization" applies to all data that can be stored in an array. Every practical real-world problem requires data representing or taken from some problem domain in the real-world. Any collection of such data must be stored in memory in such a fashion that it may be accessed during processing. Practical problem solving using computer programming uniformly uses array indexing as the means to data access during arithmetic calculation or logical decision making because of its inherent simplicity (as opposed to addressing actual memory locations). Thus, claim 1 seeks patent protection from the application of non-negative matrix factorization by digital processing by others for all practical problem solving. Claim 1 is therefore considered to be non-statutory under 35 U.S.C. 101. Claims 2-12 and 14-16 provide only further algorithmic and mathematical limitation to claim 1 and do not cure the deficiency of claim 1. Therefore claims 1-12 and 14-16 are considered to be non-statutory under 35 U.S.C. 101.

13. Claim 33 is rejected under 35 U.S.C. 101 because the claimed invention is not directed to a statutory class of inventive subject matter. Claim 33 recites a "carrier medium

carrying processor control code" which includes modulated waveforms, i.e., signals. A signal is not considered to be a process, machine, manufacture, or composition of matter and is therefore not statutory under 35 U.S.C. 101.

14. Claim 35 is rejected under 35 U.S.C. 101 because the claimed invention preempts all practical applications of the recited judicial exception of claim 1, described as an apparatus having the means for performing the steps of the algorithm of claim 1.

15. Claim 50 is rejected under 35 U.S.C. 101 for the same reason as claim 1.

16. Claims 47 and 51 is rejected under 35 U.S.C. 101 for the same reason as claim 33.

Claim Rejections - 35 USC § 102

17. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

18. Claims 1, 12, 14-22, 25-28, 30-36, 48, and 50 are rejected under 35 U.S.C. 102(b) as being anticipated by *Lee et al.* (*Lee*), "Learning the parts of objects by non-negative matrix factorization", 1999.

Regarding claim 1. *Lee* teaches a method of digitally processing data in a data array defining a target matrix (X) using non-negative matrix factorization to determine a pair of matrices (F, G), a first matrix of said pair determining a set of features for representing said data, a second matrix of said pair determining weights of said features, such that a product of said first and second matrices approximates said target matrix (*see* p. 788, col. 2, paragraph 3, *Examiner interprets Lee's matrix V to be matrix (X) and Lee's matrices W and H to be matrices (F,G).*), the method comprising:

inputting said target matrix data (X) (*see* p. 789, col. 2, Figure 1, *Examiner interprets applying the learning methods "to a database of...facial images" to comprise inputting said target matrix data (X) from facial data in the database.*);

selecting a row of said one of said first and second matrices and a column of the other of said first and second matrices (*see* p. 788, col. 2, equation (1), *Examiner interprets the iteration of the summation over a = 1,...,r to select, on each iterate, a column (a) of* W_{ia} *and a row (a) of* $H_{a\mu}$.);

determining a target contribution (R) of said selected row and column to said target matrix (*see* p. 788, col. 2, paragraph 3, *Examiner interprets an "encoding" with "a linear combination of basis images" to be a target contribution (R) of said selected row and column to said target matrix.*);

determining, subject to a non-negativity constraint, updated values for said selected row and column from said target contribution (*see* p. 790, col. 1, Figure 2, *Examiner interprets the "update rules" to determine, subject to a non-negativity constraint, updated values for said selected row and column from said target contribution.*); and

repeating said selecting and determining for the other rows and columns of said first and second matrices until all said rows and columns have been updated (*see* p. 789, col. 2, First full paragraph, *Examiner interprets the iteration of the update rules until a local maximum of the objective function is obtained to comprise repeating said selecting and determining*

for the other rows and columns of said first and second matrices until all said rows and columns have been updated.).

Regarding claim 12. *Lee* teaches a method as claimed in claim 1, further comprising initialising said first and second matrices (*see* p. 791, col. 2, §Methods, *Examiner interprets "random initial conditions for W and H" to require initialising said first and second matrices with random values.*).

Regarding claim 14. A method as claimed in claim 1, wherein said determining subject to a non-negativity constraint comprises setting a said updated value to substantially zero where the updated value would otherwise be negative (*see* p. 790, col. 1, Figure 2, "The update rules preserve the non-negativity of W and H and also constrain the columns of W to sum to unity.", *Examiner interprets the fact that the update rules constrain "the columns of W to sum to unity" to mean that the updating rules comprises setting a said updated value (for both W and H) to substantially zero where the updated value would otherwise be negative in order that the column values of W always sum to unity.*).

Regarding claim 15. A method as claimed in claim 1, further comprising constraining said updated values to lie between a minimum and a maximum value (*see* p. 790, col. 1, Figure 2, "The update rules preserve the non-negativity of W and H and also constrain the columns of W to sum to unity.", *Examiner interprets the fact that the update rules constrain "the columns of W to sum to unity" to mean that the updating rules comprise constraining said updated values (for both W and H) to lie between a minimum and a maximum value (both* substantially zero where the updated value would otherwise be negative*) in order that the column values of W always sum to unity.*).

Regarding claim 16. A method as claimed in claim 1, further comprising repeating said updating of all said rows and columns of said first and second matrices for a plurality of iterations (*see* p. 789, col. 2, "We implemented NMF with the update rules for W and H given in Fig. 2.", *Examiner interprets the fact the update rules were for W and H, as opposed to some particular tow or column within W or H, the method comprises repeating said updating of all said rows and columns of said first and second matrices for a plurality of iterations.*).

Regarding claim 17. *Lee* teaches a method as claimed in claim 1, wherein said data comprises image data defining an image, and wherein said set of features determined by said first matrix comprises a set of subframes which when combined according to said weights determined by said second matrix approximate said image (*see* p. 789, col. 2, Figure 1, *Examiner interprets "facial images, each consisting of n = 19 x 19 pixels, and constituting an n x m matrix V" to be data comprising image data defining an image. Examiner interprets "the 7 x 7 montages to be subframes (of the 19 x 19 "facial images") combined according to linear superposition of a set of features determined by said first matrix (i.e., basis images represented by the columns of W) and weights determined by said second matrix (i.e., the encodings of the columns of H).*).

Regarding claim 18. *Lee* teaches a method of driving a display comprising a plurality of pixels arranged in rows and columns, the method comprising employing the method of claim 1 to process data for display as said target matrix data (X) to determine said first and second matrices (F,G), and driving said display to form an image using a plurality of subframes, each subframe

having said rows and columns of pixels driven responsive to a row of one of said first and second matrices and a column of the other of said first and second matrices (*see* p. 789, col. 2, Figure 1, *Examiner interprets the method of the Methods section (p. 791, col 2) to be a method of driving a display comprising a plurality of pixels arranged in rows and columns, the method comprising employing the method of claim 1. Examiner interprets using "facial images, each consisting of n = 19 x 19 pixels, and constituting an n x m matrix V" to be data for display as said target matrix data (X). Examiner interprets "the 7 x 7 montages to be a plurality of subframes (of the 19 x 19 "facial images"), each subframe having said rows and columns of pixels driven responsive to a row of one of said first and second matrices and a column of the other of said first and second matrices, according to linear superposition of a set of features determined by said first matrix (i.e., basis images represented by the columns of W) and weights determined by said second matrix (i.e., the encodings of the columns of H)*.)).

Regarding claim 19. *Lee* teaches a method of image matching (*see* p. 791, col. 1, paragraph 2, Examiner interprets "infers values

for the hidden variables from the visible variables" to comprise image matching.), the method comprising

inputting target image data for matching as said target matrix data (*see* p. 789, col. 2, Figure 1, *Examiner interprets applying the learning methods "to a database of...facial images" to comprise inputting said target matrix data (X) from facial data in the database.*);

processing said image data as claimed in claim 1 to determine said first and second matrices (*see* p. 789, col. 2, first full paragraph, *Examiner interprets the iteration of the update rules until a local maximum of the objective function is obtained to be processing said image data as claimed in claim 1 to determine said first and second matrices.*);

comparing data from at least one of said first and second matrices with stored data comprising data for a corresponding first and/or second matrix for a second image(*see* p. 790, col. 1, first paragraph, *Examiner interprets "coactivation in V, as the image pixels belonging to the same part of the face are coactivated when that part is present" to comprise comparing data from at least one of said first and second matrices with stored data comprising data for a corresponding first and/or second matrix for a second image.*); and

outputting image match data responsive to said comparing (*see* above, Examiner interprets "*coactivation*" to comprise outputting image match data (i.e., making it visible on the display) responsive to said comparing.).

Regarding claim 20. *Lee* teaches a method as claimed in claim 19 wherein said stored data comprises data for a plurality of images held in a non-volatile store in the form of at least one of said first matrix said second matrix (*see* above and p. 791, §Methods, *Examiner interprets W and H, which comprise data for a plurality of images, to be held in a non-volatile store (i.e., the disk memory of "a Pentium II computer") in the form of at least one of said first matrix said second matrix.*).

Regarding claim 21. *Lee* teaches a method as claimed in claim 19 wherein said stored data comprises stored data derived from said second image, the method further comprising inputting said second image data and processing said data input to determine said first and second matrices for said second image (*see* above, Examiner interprets the "*database of...facial images" to* input said second image data and "*a Pentium II computer*" to process

said data input to determine said first and second matrices for said second image (i.e., “7 x 7 montages” (Figure 1)).).

Regarding claim 22. *Lee* teaches a method as claimed in claim 19, wherein both said target image data and said second image data define a biometric image, in particular a facial image (*see* above, *Examiner interprets a "database of...facial images" to be target image data and the "7 x 7 montages" (Figure 1) to be said second image data. Examiner interprets both to define a biometric image.*).

Regarding claim 25. *Lee* teaches a method of data mining (*see* p. 790, col. 1, paragraph 3, *Examiner considers summarizing a "corpus of documents" to be data mining.*), the method comprising:

applying the method of claim 1 to data stored in a database to determine a set of discovered features (*see* p. 790, col. 1, paragraphs 3-4, *Examiner interprets "hidden variables...called semantic variables" to be a set of discovered features.*); and

outputting analysis data derived from expression of said stored data in terms of said discovered features (*see* Figure 4 and p. 790, col. 2, paragraphs 1-4, *Examiner interprets "the semantic analysis of a corpus of encyclopedia articles" to be data analysis. Examiner interprets the "darkness of the text" which "indicates the relative frequency of each word within a feature" to be output analysis data derived from expression of said stored data in terms of said discovered features (i.e., matrices W and H).*).

Regarding claim 26. *Lee* teaches a method of processing sensor data (*see* p. 788, col. 2, *Examiner interprets "a database of facial images" as show in Figure 1 to comprise sensor (e.g., a camera) data.*), the method comprising:

inputting said sensor data as a data array (*see* p. 789, col. 2, Figure 1, *Examiner interprets applying the learning methods "to a database of...facial images" to comprise inputting said sensor data as a data array.*); and

processing said sensor data using the method of claim 1 (*see* p. 789, col. 2, First full paragraph, *Examiner interprets the iteration of the update rules until a local maximum of the*

objective function is obtained to comprise processing said sensor data using the method of claim 1.); and

outputting said processed data expressed in terms of a set of said features (*see* p. 789, col. 2, "In this model, an image pixel $V_{i\mu}$ is generated by adding Poisson noise to the product $(WH)_{i\mu}$.", *Examiner interprets the columns of W (i.e., "the images in V from the basis W") to be a set of said features. Examiner interprets the pixel $V_{i\mu}$ to not comprise an image until it is output.*).

Regarding claim 27. *Lee* teaches a method of analyzing biological data (*see* p. 788, col. 2, paragraph 2, *Examiner interprets "a database of facial images" to be biological data.*), the method comprising:

inputting said biological data (*see* p. 788, col. 2, paragraph 2, *Examiner interprets learning "to represent a face as a linear combination of basis images" using "a database of facial images" to comprise a step of inputting said biological data.*);

processing said biological data using the method of claim 1 to determine feature data representing features for said

biological data (*see* p. 788, col. 2, paragraph 2, *Examiner interprets learning "to represent a face as a linear combination of basis images" using "a database of facial images" to comprise a step of processing said biological data.*); and

analyzing said biological data using said feature data (*see* p. 788, col. 2, paragraph 2, *Examiner interprets "a database of facial images" to be biological data. Examiner interprets the "NMF...basis" which "are localized features that correspond better with intuitive notions of the parts of faces" to be feature data in the columns of matrix W. Examiner interprets the factorization of image matrix V into WH to be analyzing said biological data using said feature data.*).

Regarding claim 28. *Lee* teaches a method as claimed in claim 27 wherein said biological data comprises atomic coordinate data and wherein said features correspond to physically similar or complementary features of biological entities (*see* Figure 1 and p. 788, col. 2, paragraph 2, *Examiner interprets "a database of facial images" to be biological data. Examiner interprets "$V_{i\mu}$", "W_{ia}", and "$H_{a\mu}$" to be atomic coordinate data. using "a database of facial images" to comprise a step of inputting said biological data. Examiner interprets Figure 1 to show the*

linearly combined features of W_{ia} correspond to physically similar or complementary features of biological entities (i.e., human faces).).

Regarding claim 30. *Lee* teaches a method of teaching a data processing system (see p. 788, col. 2, paragraph 1, "Here we demonstrate an algorithm for non-negative matrix factorization that is able to learn parts of faces and semantic features of text.", *Examiner interprets learning to be corollary to teaching. Therefore, Lee teaches an algorithm that is able to teach itself "parts of faces and semantic features of text"*.), the method comprising:

inputting data object data for a plurality of instances of data objects about which said data processing system is to learn (*see* p. 788, col. 2, paragraph 2, *Examiner interprets "a database of facial images" to be used for inputting data object data for a plurality of instances of data objects about which said data processing system is to learn. Examiner interprets the data object to be "frontal views hand-aligned in a 19 x 19 grid" (see p. 791, col. 2, §Methods). Examiner interprets the plurality of instances of data objects about which said data processing system is to learn to be the pixels in each 19 x 19*

grid for each image (see p. 790, col. 1, Note that the update rules address pixels).);

processing said data object data using the method of claim 1 to identify feature data defining one or more features defining characteristics of said objects (*see p. 790, col. 1, Figure 2, Examiner interprets starting "from nonnegative initial conditions for W and H" and iterating "these update rules for non-negative V" to find "an approximate factorization V ≈ WH by converging to a local maximum of the objective function given in equation (2)" to comprise processing said data object data using the method of claim 1 to identify feature data defining one or more features defining characteristics of said objects.*); and

updating an information store of said data processing system using said feature data (*see p. 791, col. 2, §Methods, Examiner interprets "the results shown are after 500 iterations...on a Pentium II computer" to require updating an information store of said data processing system using said feature data for, at least, the final matrix W.*).

Regarding claim 31. A method as claimed in claim 30 wherein a number or dimension of said features is less than a number of

attributes or dimension of said objects (*see* p. 788, col. 2, paragraph 4, *Examiner interprets the "rank r of the factorization" to be a number or dimension of the weighted features of matrix, WH, such that "$(n + m)r < nm$" where n is the "non-negative pixel values of one of the m facial images". Note that $(n + m)r < nm$ implies $[(n + m)/nm]r < 1$ which implies that $(1/m + 1/n)r < 1$. Clearly if we let $r=n$, then $(1/m + 1/n)r < 1$ becomes $n/m + 1 < 1$ which is false. Therefore $r < n$.*).

Regarding claim 32. A method of data analysis (*see* p. 788, col. 2, paragraph 1, "Here we demonstrate an algorithm for non-negative matrix factorization that is able to learn parts of faces and semantic features of text.", *Examiner interprets learning parts of faces to comprise analysis of faces.*), the method comprising:

inputting data for analysis (*see p. 791, col. 2, §Methods, "For each image, the greyscale intensities were first linearly scaled so that the pixel mean and standard deviation were equal to 0.25, and then clipped to the range [0,1].", Examiner interprets clipping the image "to the range [0,1]" to require inputting data for analysis.*);

processing said data for analysis using the method of claim 1 to determine feature data representing a plurality of features of said data for analysis (see above, *Examiner interprets clipping the image "to the range [0,1]" to be processing said data for analysis using the method of claim 1 to determine feature data representing a plurality of features of said data for analysis.*); and

analyzing said data for analysis by analyzing said feature data (*see* p. 788, col. 2, paragraph 1, "Here we demonstrate an algorithm for non-negative matrix factorization that is able to learn parts of faces and semantic features of text.", *Examiner interprets learning parts of faces by* non-negative matrix factorization *to comprise analyzing said data for analysis by analyzing said feature data.*).

Regarding claim 33. *Lee* teaches a carrier medium carrying processor control code, to, when running, implement the method of claim 1 (*see* p. 791, §Methods, *Examiner interprets the RAM of "a Pentium II computer" to be a carrier medium carrying processor control code, to, when running, implement the method of claim 1.*).

Regarding claim 34. *Lee* teaches a computer system inputting said target matrix data (X) (*see* p. 791, §Methods, *Examiner interprets "a Pentium II computer" plus the software implementing the algorithm used to be a computer system inputting said target matrix data (i.e., "facial images").*), the system comprising:

an input for said data for said data array (*see* p. 789, col. 2, Figure 1, *Examiner interprets applying the learning methods "to a database of...facial images" to be an input for said data for said data array.*);

an output for outputting said first and second matrices (*see* p. 791, §Methods, *Examiner interprets the display screen of "a Pentium II computer" to be an output for outputting said first and second matrices.*);

data memory for storing said target matrix and said pair of matrices (*see* p. 791, §Methods, *Examiner interprets the RAM of "a Pentium II computer" to be a data memory for storing said target matrix and said pair of matrices.*);

program memory storing processor control code (*see* p. 791, §Methods, *Examiner interprets the RAM of "a Pentium II computer" to be a program memory storing processor control code.*); and

a processor coupled to said input, to said output, to said data memory and to said program memory for loading and implementing said processor control code, said code comprising code to, when running implement the method of claim 1 (*see* p. 791, §Methods, *Examiner interprets "a Pentium II computer" to comprise a processor coupled to said input, to said output, to said data memory and to said program memory for loading and implementing said processor control code, said code comprising code to, when running implement the method of claim 1.*).

Regarding claim 35. *Lee* teaches an apparatus for digitally processing data in a data array defining a target matrix (X) using non-negative matrix factorization to determine a pair of matrices (F, G), a first matrix of said pair determining a set of features for representing said data, a second matrix of said pair determining weights of said features, such that a product of said first and second matrices approximates said target matrix (*see* p. 791, col. 2, §Methods, Examiner interprets "a Pentium II computer" to be an apparatus for digitally processing

data in a data array defining a target matrix (X) using non-negative matrix factorization to determine a pair of matrices (F, G), a first matrix of said pair determining a set of features for representing said data, a second matrix of said pair determining weights of said features, such that a product of said first and second matrices approximates said target matrix.), the apparatus comprising:

means for inputting said target matrix data (X) (*see* p. 789, col. 2, Figure 1, *Examiner interprets "a database of...facial images" to be a means for inputting said target matrix data (X)*.);

means for selecting a row of said one of said first and second matrices and a column of the other of said first and second matrices (*see* p. 788, col. 2, equation (1), *Examiner interprets the summation over a = 1,...,r which selects, on each iterate, a column (a) of* W_{ia} *and a row (a) of* $H_{a\mu}$ *to be a means for selecting a row of said one of said first and second matrices and a column of the other of said first and second matrices*.);

means for determining a target contribution (R) of said selected row and column to said target matrix (*see* p. 788, col. 2, paragraph 3, *Examiner interprets an "encoding" with "a linear*

combination of basis images" to be a means for determining a target contribution (R) of said selected row and column to said target matrix.);

means for determining, subject to a non-negativity constraint, updated values for said selected row and column from said target contribution (see p. 790, col. 1, Figure 2, *Examiner interprets the "update rules" which determine, subject to a non-negativity constraint, updated values for said selected row and column from said target contribution to be a means for determining, subject to a non-negativity constraint, updated values for said selected row and column from said target contribution.*); and

means for repeating said selecting and determining for the other rows and columns of said first and second matrices until all said rows and columns have been updated (*see* p. 789, col. 2, First full paragraph, *Examiner interprets the iteration of the update rules until a local maximum of the objective function is obtained to comprise a means for repeating said selecting and determining for the other rows and columns of said first and second matrices until all said rows and columns have been updated.*).

Regarding claim 36. *Lee* teaches a method of driving an electro-optic display, the display having a matrix of pixels (*see* p. 791, col. 2, §Methods, *Examiner interprets the video drivers for "a Pentium II computer" graphics card to comprise a method of driving an electro-optic display, the display having a matrix of pixels.*), the method comprising:

inputting image data for said matrix of pixels into an image data matrix (*see* p. 789, col. 2, Figure 1, *Examiner interprets applying the learning methods "to a database of...facial images" to comprise inputting image data for said matrix of pixels into an image data matrix.*);

factorizing said image data matrix into a product of first and second factor matrices (*see* pp. 789-790, *Examiner interprets applying the "update rules for W and H given in Fig. 2" by iteration until the "update rules converges to a local maximum of the objective function" (equation (2)) to comprise factorizing said image data matrix into a product of first and second factor matrices.*); and

driving said display using said factor matrices (*see* p. 789, col. 2, Figure 1, *Examiner interprets the basis images shown in "the 7x7 montages" to use the factor matrices W and H and to drive the display (to produce the images shown).*); and

wherein said factorizing comprising iteratively adjusting said factor matrices such that their product approaches said image data matrix (*see* p. 790, col. 1, Figure 2); and

wherein said iterative adjusting comprises adjusting each row of one of said factor matrices and each column of the other of said factor matrices in turn (*see* p. 790, col. 1, Figure 2, *Examiner interprets* W_{ia} *<-* W_{ia}**Update to adjust each column (a) of W and* $H_{a\mu}$ *<-* $H_{a\mu}$**Update to adjust each row (a) of H.*).

Regarding claim 48. *Lee* teaches a driver for an electro-optic display, the display having a matrix of pixels (*see* p. 791, col. 2, §Methods, *Examiner interprets the video driver for "a Pentium II computer" graphics card to be a driver for an electro-optic display, the display having a matrix of pixels.*), the driver comprising:

an input to input image data for said matrix of pixels into an image data matrix (*see* p. 789, col. 2, Figure 1, *Examiner interprets "a database of...facial images" to be an input to input image data for said matrix of pixels into an image data matrix.*);

a matrix factorization system to factorize said image data matrix into a product of first and second factor matrices (*see* p. 791, col. 2, §Methods, *Examiner interprets the "Pentium II computer" plus software used to implement the algorithm used to be a matrix factorization system to factorize said image data matrix into a product of first and second factor matrices.*); and

a driver output to drive said display using said factor matrices, and wherein said matrix factorization system is configured to iteratively adjust said factor matrices, such that their product approaches said image data matrix, by adjusting each row of one of said factor matrices and each column of the other of said factor matrices in turn (*see* p. 791, col. 2, §Methods, *Examiner interprets the graphics card of "a Pentium II computer" to comprise a driver output to drive said display using said factor matrices as the said matrix factorization system (i.e., "a Pentium II computer") is configured (i.e., programmed) to iteratively adjust said factor matrices, such that their product approaches said image data matrix, by adjusting each row of one of said factor matrices and each column of the other of said factor matrices in turn (see Figure 2).*).

Regarding claim 50. *Lee* teaches a method of processing a data array defining a target matrix (X) to determine a pair of factor matrices (F,G) such that a product of said factor matrices approximates said target matrix (X) (*see* p. 788, col. 2, equation (1), paragraph 3, *Examiner interprets Lee's matrix V to be matrix (X) and Lee's matrices W and H to be matrices (F,G). Examiner interprets equation (1) to determine a pair of factor matrices (F,G) such that a product of said factor matrices approximates said target matrix.*), the method comprising:

determining for a single row or column of a first said factor matrix a value to which an updating rule would converge when iteratively applied, said updating rule comprising an updating rule of a factorizing algorithm which iteratively updates two factor matrices to more closely approximate a target matrix using said updating rule (*see* p. 788, col. 2, paragraph 3, *Examiner interprets an "encoding" with "a linear combination of basis images" to be a single row or column of a first said factor matrix a value to which an updating rule would converge when iteratively applied, said updating rule comprising an updating rule of a factorizing algorithm which iteratively updates two factor matrices to more closely approximate a target*

matrix using said updating rule (see p. 790, col. 1, Figure 2*).*);

updating said row or column with said determined value (*see* p. 790, col. 1, Figure 2);

repeating said determining and updating for a column or row of a second said factor matrix (*see* p. 789, col. 2, First full paragraph, *Examiner interprets the iteration of the update rules until a local maximum of the objective function is obtained to comprise repeating said determining and updating for a column or row of a second said factor matrix.*); and

repeating said determining and updating of said first and second factor matrices to update each row or column of said first factor matrix and each column or row of said second factor matrix (see p. 789, col. 2, First full paragraph, *Examiner interprets the iteration of the update rules until a local maximum of the objective function is obtained to comprise repeating said determining and updating of said first and second factor matrices to update each row or column of said first factor matrix and each column or row of said second factor matrix.*).

Allowable Subject Matter

19. Claims 14, 15, 18-32, 34, and 38-41 objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Correspondence Information

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Nathan H. Brown, Jr. whose telephone number is 571-272- 8632. The examiner can normally be reached on M-F 0830-1700. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, David Vincent can be reached on 571-272-3080. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306. Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status

information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

/Nathan H. Brown, Jr./
Examiner, Art Unit 2129
November 9, 2009

/David R Vincent/

Supervisory Patent Examiner, Art Unit 2129